



## INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

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<b>(21) International Application Number:</b> PCT/US99/10691 <b>(22) International Filing Date:</b> 14 May 1999 (14.05.99) <b>(30) Priority Data:</b> 09/102,527      22 June 1998 (22.06.98)      US <b>(71) Applicant:</b> APPLIED MATERIALS, INC. [US/US]; 3050 Bowers Avenue, Santa Clara, CA 09054 (US). <b>(72) Inventors:</b> LIU, Wei; 936 Azure Street #A12, Sunnyvale, CA 94087 (US). WANG, Yiqiong; 2678 Calico Court, Morgan Hill, CA 95037 (US). LI, Maocheng; 725 Honda Way, Fremont, CA 94539 (US). KHAN, Anisul; 1180 Lochinvar Avenue #53, Sunnyvale, CA 94087 (US). PAN, Shaoher; 1133 Kotez Drive, San Jose, CA 95120 (US). PODLESNIK, Dragan; 1736 Oak Creek Drive #209, Palo Alto, CA 94304 (US). <b>(74) Agents:</b> SIXBEY, Daniel, W. et al.; Sixbey, Friedman, Leedom & Ferguson, P.C., suite 800, 8180 gresboro Drive, McLean, VA 22102 (US).		<b>(81) Designated State:</b> JP.  <b>Published</b> <i>With international search report.</i>
<b>(54) Title:</b> SILICON TRENCH ETCHING USING SILICON-CONTAINING PRECURSORS TO REDUCE OR AVOID MASK EROSION		
<b>(57) Abstract</b> <p>The present invention pertains to an etch chemistry and method useful for the etching of silicon surfaces. Although the method may be used for applications such as trench isolation and micro machining, it is particularly useful in the deep trench etching of silicon where profile control is particularly important. In the case of deep trench etching, at least a portion toward the bottom of the trench is etched using a combination of reactive gases including fluorine-containing compound which does not contain silicon (FC); a silicon-containing compound (SC), which preferably also contains fluorine; and oxygen (O<sub>2</sub>). When the SC is a fluorine-containing silicon compound, the volumetric ratio of the FC to SC ranges from about 25:1 to about 1:10, and the volumetric ratio of the O<sub>2</sub> to SC ranges from about 10:1 to about 1:10. When the SC is a non-fluorine-containing silicon compound, the volumetric ratio of the FC to SC ranges from about 100:1 to about 1:10, with the volumetric ratio of the O<sub>2</sub> to SC ranges from about 10:1 to about 1:10. The FC compound may be selected, for example but not by way of limitation, from the following: F<sub>2</sub>O, F<sub>2</sub>O<sub>2</sub>, NF<sub>3</sub>, NOF, NO<sub>2</sub>F, SF<sub>6</sub>, SF<sub>4</sub>, S<sub>2</sub>F<sub>2</sub>, S<sub>2</sub>F<sub>10</sub>, CF<sub>4</sub>, CH<sub>2</sub>F<sub>2</sub>, CHF<sub>3</sub>, and CH<sub>3</sub>F. The most preferred FC is SF<sub>6</sub>. When the SC contains fluorine, the SC may be selected, for example, from the following: SiF<sub>4</sub>, Si<sub>2</sub>F<sub>6</sub>, SiHF<sub>3</sub>, SiH<sub>2</sub>F<sub>2</sub>, SiH<sub>3</sub>F, Si<sub>2</sub>OF<sub>6</sub>, SiCl<sub>2</sub>F<sub>2</sub>, and SiClF<sub>3</sub>. The most preferred fluorine-containing SC is SiF<sub>4</sub>. When the SC does not contain fluorine, the SC may be selected from silicon-containing compounds such as SiBr<sub>4</sub>, SiHBr<sub>3</sub>, SiH<sub>2</sub>Br<sub>2</sub>, SiH<sub>3</sub>Br, SiCl<sub>4</sub>, SiHCl<sub>3</sub>, SiH<sub>2</sub>Cl<sub>2</sub>, SiH<sub>3</sub>Cl, Si<sub>2</sub>Cl<sub>6</sub>, SiH<sub>4</sub>, Si<sub>2</sub>H<sub>6</sub>, Si<sub>3</sub>H<sub>8</sub>, Si<sub>4</sub>H<sub>10</sub>, SiH<sub>2</sub>, SiH<sub>2</sub>I, C<sub>4</sub>H<sub>12</sub>Si, and Si(C<sub>2</sub>H<sub>5</sub>O<sub>2</sub>)<sub>4</sub>, by way of example. The use of a fluorine-containing silicon compound is preferred as a means of improving the etch rate and removing debris from the etched surfaces, while providing supplemental silicon availability for protection (passivation) of the etched mask sidewall and the upper etched portion of the trench, during etching of the bottom portion of the trench.</p>		

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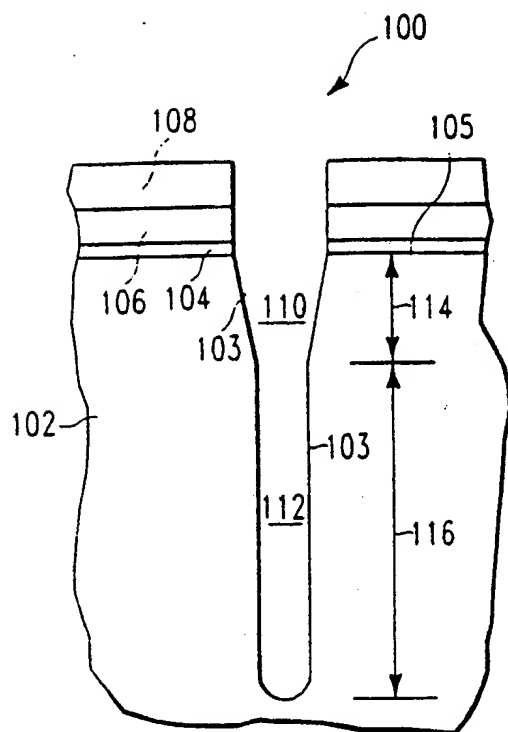


FIG. 1 (PRIOR ART STANDARD)

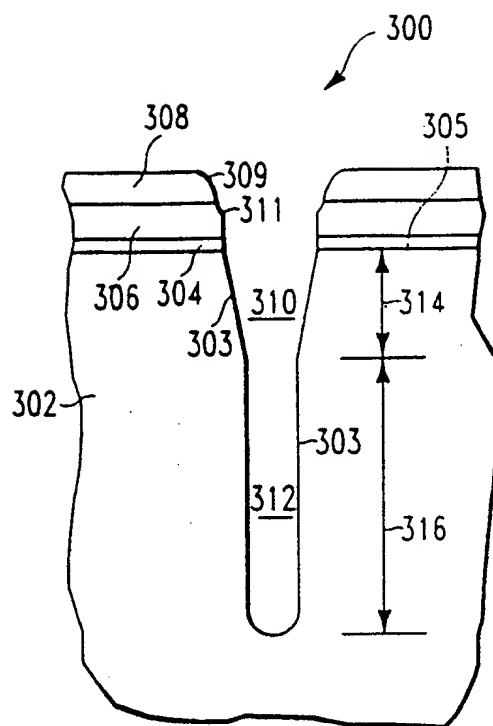


FIG. 3 (PRIOR ART)

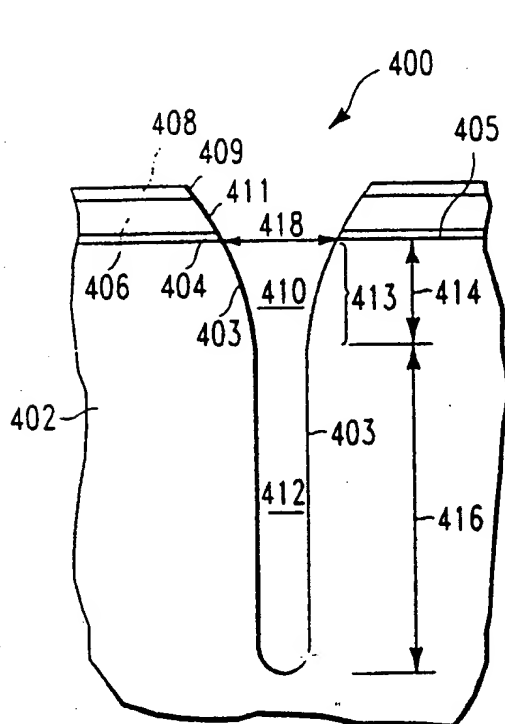


FIG. 4 (PRIOR ART)

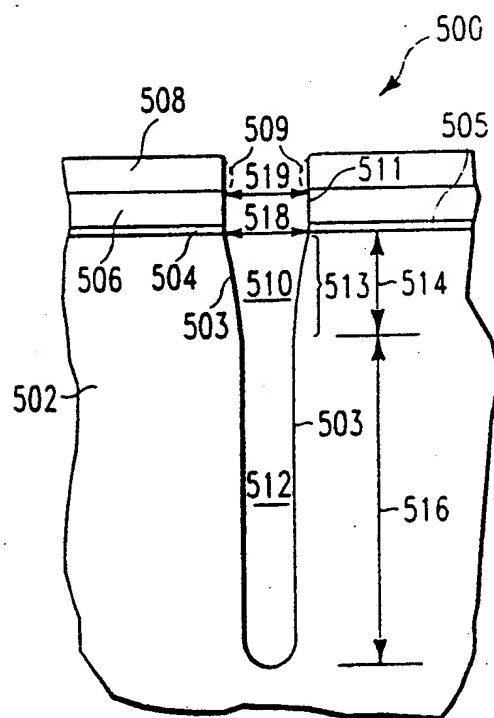


FIG. 5

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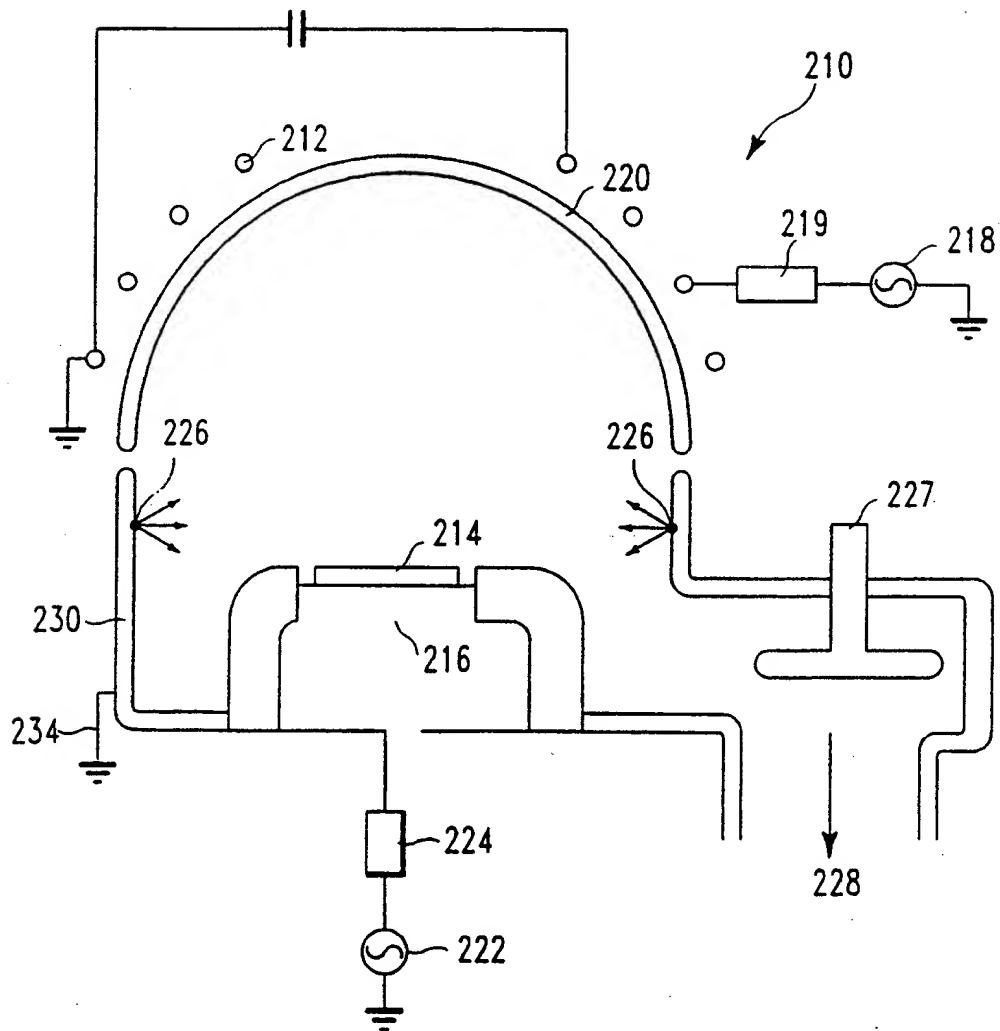


FIG. 2 (PRIOR ART)

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FIG. 6

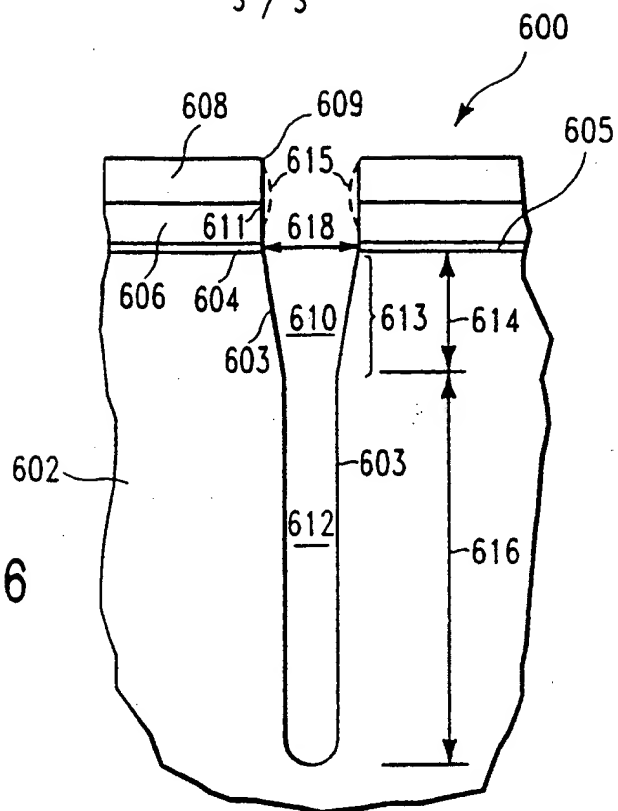


FIG. 7

